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EDITORIAL

Imaging in emergency department: Crowded with confusion!

Unlike physicians' offices and various clinics, emergency departments (ED) are open 24 h a day, 7-days a week. It is no wonder that they are crowded and that they see a fare share of patients with cardiac problems. Add to that the increasing numbers of uninsured patients, whose only recourse is to wait till problems become acute and then show up in the ED, one is less optimistic that things will get better anytime soon in the United States. There is no reason that things are any better outside United States and especially in Egypt at least at the time of the inaugural publication of the New Journal.

The long delays before patients with non-life threatening problems are seen by physicians and stretchers in the corridors in some ED facilities are symptoms of shortage of staff and limited space, which makes ED, visits to many patients truly a last resort option.

To the purest, the ED is supposed to take care of emergency problems and hence its name and in the case of the patient with chest pain (CP), the algorithm is simple, should the patient be admitted (see below) or discharged to have a follow up with his/her primary care physician or cardiologist? This means that soft plaques, calcified plaques, calcium score, molecular imaging, etc. do not offer short-term advantage. The counter argument is that for many patients they do not have a follow-up mechanism and the ED visit is their only chance to take care of their acute but also chronic (long-term) care. This means that soft plaques, calcified plaques, calcium score, molecular imaging, etc. may be important. Parenthetically, the CP units may have changed the paradigm of admit vs. do not admit. These units might be within the ED physical structure or be virtual, any where in the hospital. They allow monitoring of the patients and discharge within 24 h (so called 23 h admission). This time period allows imaging to be done if needed, biomarkers to be checked and depending on results the patient is either discharged or transferred to cardiology service. Their main appeal is that they are supposed to save money and expedite work-up process.

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Against this background, the scientific issue of how best to triage patients with chest pain in the ED comes up repeatedly? Here are some options: Standard of care/biomarkers, new biomarkers, treadmill exercise ECG, myocardial perfusion imaging (rest or stress), 2-dimensional echocardiography (2DE, rest or stress), calcium score, coronary computerized tomography angiography (CCTA), magnetic resonance imaging (MRI, rest or stress) and invasive coronary angiography. It is fair to say that the crowding in the Ed, the shortage of staff and the medico-legal concerns are amongst the reasons for the rapid growth of imaging in ED. This makes me believe that there is over utilization of imaging in ED (of any sort), which adds to cost and radiation exposure with some of the imaging modalities (SPECT and CCTA).

There are four types of patients with chest pain (CP) syndromes encountered at ED: patients with unknown coronary artery disease (CAD) (non diagnostic ECG, negative biomarkers); patients with known CAD such as those with prior myocardial infarction (MI), prior percutaneous coronary artery interventions (PCI), prior coronary artery bypass surgery (CABG) and those with prior abnormal coronary angiograms by Left heart catheterization (LHC); patients with clealry non-cardiac CP and patients with acute coronary síndromes (ACS), hemodynamic or rhythm instability. The decison-making process in the last two categories of patients is straight forwards, those with non cardiac CP require no admisión to cardiology service while those with hemodynamic instability do so and may require urgent coronary angiography, if they demonstrate ST- elevation MI.

The hallmark of decision making (send home vs. admit to treat ACS and potential referral to LHC) in these patients is identification of ischemia or "flow-limiting disease". It is not at all clear what would one do with a patient with a non-obstructive non-calcified plaque, and whether medical management would be any different if that (non-obstructive) lesion was predominantly calcified. This does not seem like a practical or promising approach for triaging decisions in the ED.

When considering imaging it is important to understand the differences between efficacy and effectiveness. Efficacy is the performance characteristic of a modality in highly selected populations in whom the test can be applied, Effectiveness:

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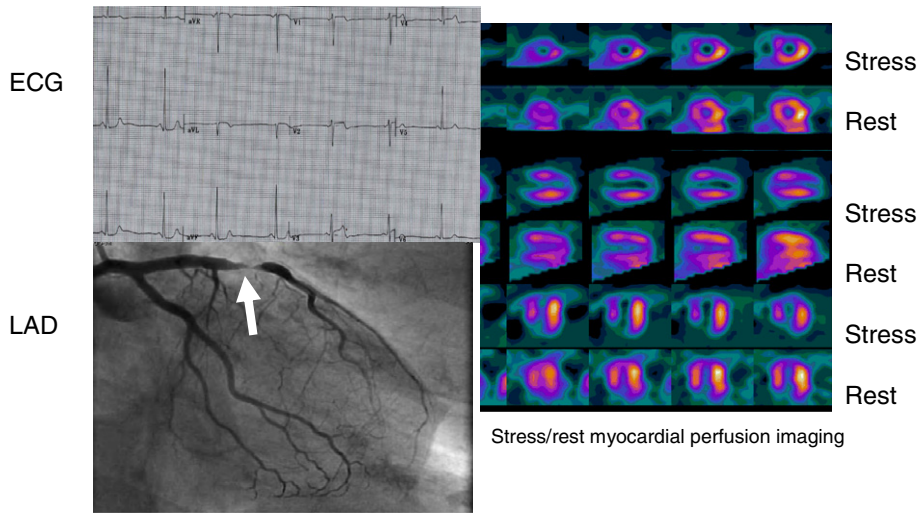

Figure 1

is the practical applicability and performance of the test in the real-world. For example, can the modality be applied in patients with renal dysfunction, devices, claustrophobia, inability to breath-hold, etc. (In the Goldstein study [JACC 2007; 49:863–871] of CCTA in the ED, 46% of screened patients were excluded for contraindications). From a practical perspective, it is important to note that there is literally no contraindication to a SPECT perfusion study, and most patients can get an interpretable study. The logistics of providing a 24/7 service is relevant and a pragmatic consideration for developing an imaging service, and is also reflected in clinical trial data.

There are many studies showing the virtues of nuclear, 2DE, CCTA, MRI and plain old treadmill test when combined with thorough clinical evaluation, ECG and biomarkers. The fact there are so many means not any one of them is perfect and ED physicians often make their choices based on availability and local expertise. Needless to say patient selection is vital for any method to be cost-effective.

At our institution, we rely on SPECT myocardial perfusion imaging and would like to address few issue related to the technique because it is not ''one size fit all''.

1. It is desirable but not practical to provide imaging 24 h per day, 7-days per week for any number of reasons. We provide rest or stress imaging during working hours 5 days per week and rest imaging during morning hours on the week- end.
2. We do rest studies (gated SPECT MPI) as soon as patient is evaluated including ECG and 1 set of biomarkers. The patient is injected while in ED and report faxed back (and call in) before the patient makes it back to the ED from the imaging suite. A stress study is often scheduled within 48 h of discharge from ED if the rest images are normal. A friendly patient-and physician-centered service is a key to success!
3. We do stress studies (gated SPECT MPI) either with pharmacological stress (usually) or treadmill exercise after the rest study if time permits on same day.
4. We do stress studies (gated SPECT MPI) either with pharmacological stress (usually) or treadmill exercise as the initial study provided the patient is stable and has two sets of normal biomarkers. If the stress study is normal, we do not do rest study to save time, radiation exposure and to lower cost. We do however rest studies if the stress study is abnormal or equivocal. Patients with clear cut ischemia usually undergo LHC soon after imaging, on the same day.
5. The question often comes up as how comfortable are we in excluding ischemia if the tracer is injected after subsidence of CP? The answer, not very. There are two studies that used balloon occlusion model at time of PTCA to study this phenomenon and there findings were different. In this model, patients with coronary stenosis undergoing PTCA, the balloon is inflated at stenosis site and Tc-99m sestamibi is injected IV a. the balloon is then deflated and images are obtained after the conclusion of the procedure (the images represent the flow perturbation at time of tracer injection and not imaging). In one study, all patients had tracer injection at balloon occlusion and then 1/3 had another injection at I h, 1/3 at 2 h and 1/3 at 3 h. Perfusion defects were seen in 37% of these patients when imaged after the 2nd injection. The authors concluded that MPI may remain abnormal for several hours following transient myocardial ischemia even when normal flow is restored in the epicardial coronary artery. A more logical explanation is that the perfusion defects after 2nd injection is a shine through phenomenon created by the 1st injection at time of balloon occlusion. Our results showed that if patients were injected at time of balloon occlusion and no 2nd injection is made only few showed perfusion defects at 1–2 h. The message is this, inject during or as close to pain as possible.
6. It is more difficult to read Ed images than standard images because as often is the case there is only one set of images and because perfusion defects are not usually severe or extensive. So some training and adjusting of thresholds is needed and attenuation correction is helpful.
7. It is important to evaluate your own data by systemic review of outcome defined as the need for re-admission, LHC, PTCA, CABG or death at 30 days and 1 year to

have credible data; experience somewhere else is not a substitute to your own data. We have done that many times over in the past 10 years and the results are gratifying.

8. A particularly challenging but increasing group of patients are those with known CAD as defined earlier. The presence of normal MPI is assuring in these patients but the presence of an abnormality at rest is less helpful as it could denote new MI. old MI or ischemia. A stress study is needed on the 2nd day. When doing the stress study when not only the stress study is done but a repeat rest study. If the perfusion abnormality is not present on repeat rest study that by itself is an indication that the patient had ischemia.
9. With any ischemia, there are a number of changes in myocardial blood flow, function, metabolism and innervation. Some of these changes in metabolism and innervation have been images as they tend to last longer than the flow changes or even mechanical stunning (so called memory imaging). The CCTA will likely show CAD in these patients but the question here is the pain due to ischemia or is it non-cardiac? A completely different set of questions.
10. A troubling issue is with the ''frequent flyers''; these are patients who come to ED frequently with same bizarre complaints. My advice is to avoid repeat imaging at any cost.

In summary, I see a role of imaging in the ED but that should not be an invitation to inappropriate and over-utilization. If done properly, it could save lives as shown in Fig. 1 attached of patient with intermediate likelihood of CAD and negative biomarkers. A severe stenosis of the left anterior descending artery was found by coronary angiography even though the story was not very convincing and the ECG and biomarkers were negative.

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